Amazon Web Services IN ACTION

SECOND EDITION

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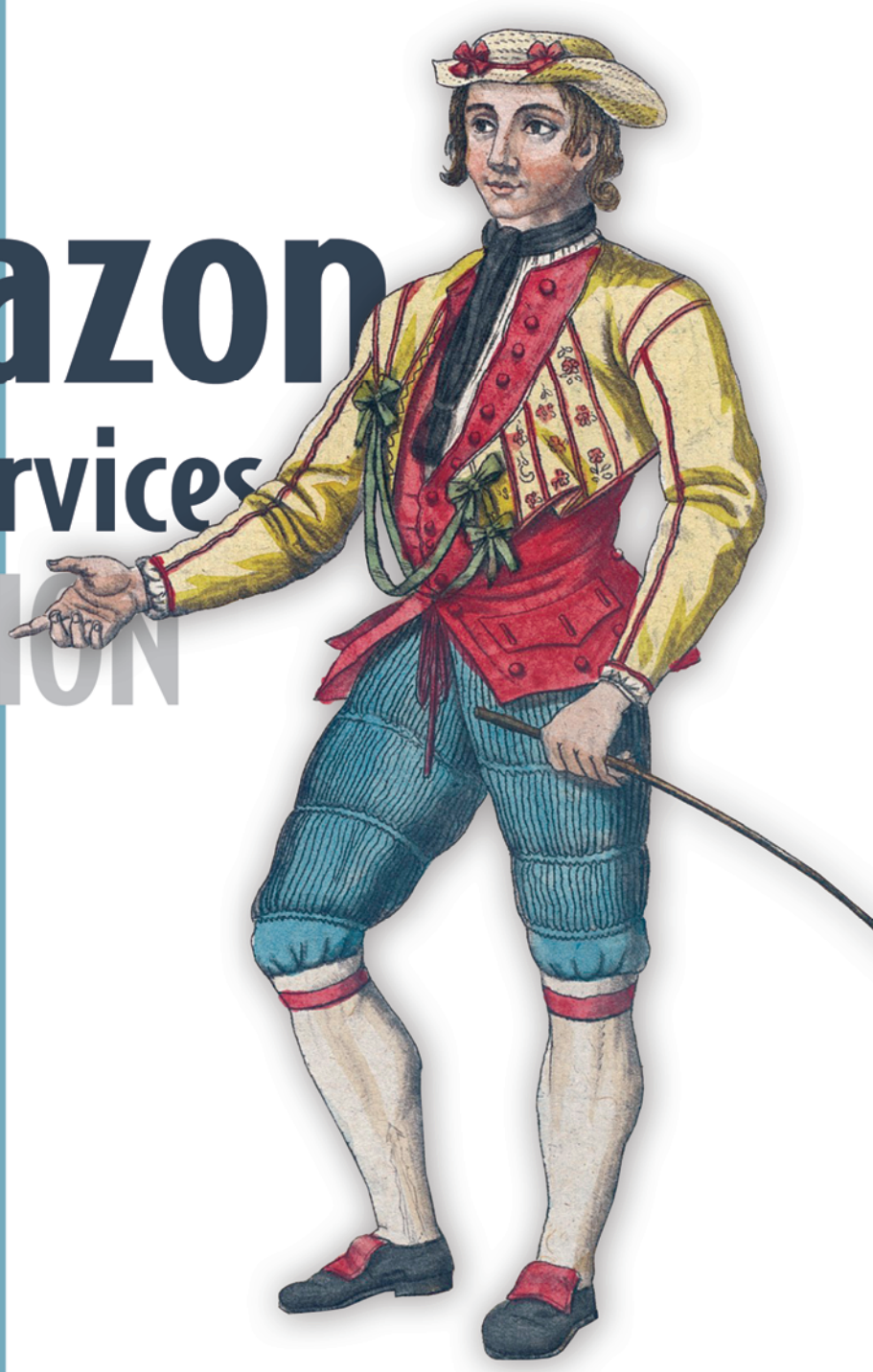
Foreword by Ben Whaley



MANNING

Compute & Networking

Abbr.	Name	Description	Where
EC2	Amazon Elastic Compute Cloud	Virtual machines with Linux and Windows	3
	AWS Lambda	Run code without the need for virtual machines	7
EIP	Elastic IP Address	Fixed public IP address for EC2 instances	3.6
ENI	Amazon EC2 Elastic Network Interface	Virtual network interface for EC2 instances	3.7
VPC	Amazon Virtual Private Cloud	Private network inside the cloud	6.5
	Amazon EC2 Security Group	Network firewall	6.4

Deployment & Management

Abbr.	Name	Description	Where
	AWS Elastic Beanstalk	Deployment tool for simple applications	5.4
	AWS OpsWorks	Deployment tool for multilayer applications	5.5
	AWS CloudFormation	Infrastructure automation and deployment tool	5.3
IAM	AWS Identity and Access Management	Secure access to your cloud resources (authentication and authorization)	6.3
CLI	AWS command-line interface	AWS in your terminal	4.2
SDK	AWS software development kits	AWS in your applications	4.3

Praise for the First Edition

Fantastic introduction to cloud basics with excellent real-world examples.

—Rambabu Posa, GL Assessment

A very thorough and practical guide to everything AWS … highly recommended.

—Scott M. King, Amazon

Cuts through the vast expanse of official documentation and gives you what you need to make AWS work now!

—Carm Vecchio, Computer Science Corporation (CSC)

The right book to program AWS from scratch.

—Javier Muñoz Mellid, Senior Computer Engineer, Igalia

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Shelter Island

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foreword

Throughout the late 1990s and early 2000s I worked in the rank and file of system administrators endeavoring to keep network services online, secure, and available to users. At the time, administration was a tedious, onerous affair involving cable slinging, server racking, installing from optical media, and configuring software manually. It was thankless work, often an exercise in frustration, requiring patience, persistence, and plenty of caffeine. To participate in the emerging online marketplace, businesses of the era bore the burden of managing this physical infrastructure, accepting the associated capital and operating costs and hoping for enough success to justify those expenses.

When Amazon Web Services emerged in 2006, it signaled a shift in the industry. Management of compute and storage resources was dramatically simplified, and the cost of building and launching applications plummeted. Suddenly anyone with a good idea and the ability to execute could build a global business on world-class infrastructure at a starting cost of just a few cents an hour. The AWS value proposition was immediately apparent, ushering in a wave of new startups, data center migrations, and third-party service providers. In terms of cumulative disruption of an established market, a few technologies stand above all others, and AWS is among them.

Today, the march of progress continues unabated. In December 2017 at its annual re:Invent conference in Las Vegas, Werner Vogels, CTO of Amazon, announced to more than 40,000 attendees that the company had released 3,951 new features and services since the first conference in 2012. AWS has an $18 billion annual run rate and 40% year-over-year growth. Enterprises, startups, and governments alike have adopted the AWS cloud en masse. The numbers are staggering, and AWS shows no signs of slowing down.

Needless to say, this growth and innovation comes at the expense of considerable complexity. The AWS cloud is composed of scores of services and thousands of features, enabling powerful new applications and highly efficient designs. But it is accompanied by a brand-new lexicon with distinct architectural and technical best practices. The platform can bewilder the neophyte. How does one know where to begin?

Amazon Web Services in Action, Second Edition, slices through the complexity of AWS using examples and visuals to cement knowledge in the minds of readers. Andreas and Michael focus on the most prominent services and features that users are most likely to need. Code snippets are sprinkled throughout each chapter, reinforcing the programmable nature of the cloud. And because many readers will be footing the bill from AWS personally, any examples that incur charges are called out explicitly throughout the text.

As a consultant, author, and at heart an engineer, I celebrate all efforts to introduce the bewildering world of cloud computing to new users. *Amazon Web Services in Action, Second Edition* is at the head of the pack as a confident, practical guide through the maze of the industry's leading cloud platform.

With this book as your sidekick, what will you build on the AWS cloud?

—Ben Whaley, AWS community hero and author

preface

When we started our career as software developers in 2008, we didn't care about operations. We wrote code, and someone else was responsible for deployment and operations. There was a huge gap between software development and IT operations. On top of that, releasing new features was a huge risk because it was impossible to test all the changes to software and infrastructure manually. Every six months, when new features needed to be deployed, we experienced a nightmare.

Time passed, and in 2012 we became responsible for a product: an online banking platform. Our goal was to iterate quickly and to be able to release new features to the product every week. Our software was responsible for managing money, so the quality and security of the software and infrastructure was as important as the ability to innovate. But the inflexible on-premises infrastructure and the outdated process of deploying software made that goal impossible to reach. We started to look for a better way.

Our search led us to Amazon Web Services, which offered us a flexible and reliable way to build and operate our applications. The possibility of automating every part of our infrastructure was fascinating. Step by step, we dove into the different AWS services, from virtual machines to distributed message queues. Being able to outsource tasks like operating an SQL database or a load balancer saved us a lot of time. We invested this time in automating testing and operations for our entire infrastructure.

Technical aspects weren't the only things that changed during this transformation to the cloud. After a while the software architecture changed from a monolithic application to microservices, and the separation between software development and operations disappeared. Instead we built our organization around the core principle of DevOps: you build it, you run it.

We have worked as independent consultants since 2015, helping our clients get the most out of AWS. We've accompanied startups, mid-sized companies, and enterprises on their journey to the cloud. Besides designing and implementing cloud architectures based on AWS services, we are focusing on infrastructure as code, continuous deployment, Docker, serverless, security, and monitoring.

We enjoyed writing the first edition of our book in 2015. The astonishing support from Manning and our MEAP readers allowed us to finish the whole book in only nine months. Above all, it was a pleasure to observe you—our readers—using our book to get started with AWS or deepen your knowledge.

AWS is innovating and constantly releases new features or whole new services. Therefore, it was about time to update our book in 2017. We started to work on the second edition of our book in June. Within six months we updated all chapters, added three more chapters, and improved the book based on the feedback of our readers and our editors.

We hope you enjoy the second edition of *Amazon Web Services in Action* as much as we do!

acknowledgments

Writing a book is time-consuming. We invested our time, and other people did as well. We think that time is the most valuable resource on Earth, and we want to honor every minute spent by the people who helped us with this book.

To all the readers who bought the first edition of our book: thanks so much for your trust and support. Watching you reading our book and working through the examples boosted our motivation. Also, we learned quite a bit from your feedback.

Next, we want to thank all the readers who bought the MEAP edition of this book. Thanks for overlooking the rough edges and focusing on learning about AWS instead. Your feedback helped us to polish the version of the book that you are now reading.

Thank you to all the people who posted comments in the Book Forum and who provided excellent feedback that improved the book.

In addition, thanks to all the reviewers of the second and first edition who provided detailed comments from the first to the last page. The reviewers for this second edition are Antonio Pessolano, Ariel Gamino, Christian Bridge-Harrington, Christof Marte, Eric Hammond, Gary Hubbart, Hazem Farahat, Jean-Pol Landrain, Jim Amrhein, John Guthrie, Jose San Leandro, Lynn Langit, Maciej Drozdzowski, Manoj Agarwal, Peeyush Maharshi, Philip Patterson, Ryan Burrows, Shaun Hickson, Terry Rickman, and Thorsten Höger. Your feedback helped shape this book—we hope you like it as much as we do.

Special thanks to Michael Labib for his input and feedback on chapter 12 covering AWS ElastiCache.

Furthermore, we want to thank John Hyaduck, our technical developmental editor. Your unbiased and technical view on Amazon Web Services and our book helped to perfect the second edition. Thanks to Jonathan Thoms, the technical editor of the first edition as well.

David Fombella Pombal and Doug Warren made sure all the examples within our book are working as expected. Thanks for proofing the technical parts of our book.

We also want to thank Manning Publications for placing their trust in us. Especially, we want to thank the following staff at Manning for their excellent work:

- Frances Lefkowitz, our development editor, who guided us through the process of writing the second edition. Her writing and teaching expertise is noticeable in every part of our book. Thanks for your support.
- Dan Maharry, our development editor while writing the first edition. Thanks for taking us by the hand from writing the first pages to finishing our first book.
- Aleksandar Dragosavljević, who organized the reviews of our book. Thanks for making sure we got valuable feedback from our readers.
- Benjamin Berg and Tiffany Taylor, who perfected our English. We know you had a hard time with us, but our mother tongue is German, and we thank you for your efforts.
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- Janet Vail, Deirdre Hiam, Elizabeth Martin, Mary Piergies, Gordan Salinovnic, David Novak, Barbara Mirecki, Marija Tudor, and all the others who worked behind the scenes and who took our rough draft and turned it into a real book.

Many thanks to Ben Whaley for contributing the foreword to our book.

Last but not least, we want to thank the significant people in our lives who supported us as we worked on the book. Andreas wants to thank his wife Simone, and Michael wants to thank his partner Kathrin, for their patience and encouragement.

about this book

Our book guides you from creating an AWS account to building fault-tolerant and auto-scaling applications. You will learn about services offering compute, network, and storage capacity. We get you started with everything you need to run web applications on AWS: load balancers, virtual machines, file storage, database systems, and in-memory caches.

The first part of the book introduces the principles of Amazon Web Services and gives you a first impression of the possibilities in the cloud. Next, you will learn about fundamental compute and network services. Afterward, we demonstrate six different ways to store your data. The last part of our book focuses on highly available or even fault-tolerant architectures that allow you to scale your infrastructure dynamically as well.

Amazon offers a wide variety of services. Unfortunately, the number of pages within a book is limited. Therefore, we had to skip topics such as containers, big data, and machine learning. We cover the basic or most important services, though.

Automation sneaks in throughout the book, so by the end you'll be comfortable with using AWS CloudFormation, an infrastructure-as-code tool that allows you to manage your cloud infrastructure in an automated way; this will be one of the most important things you will learn from our book.

Most of our examples use popular web applications to demonstrate important points. We use tools offered by AWS instead of third-party tools whenever possible, as we appreciate the quality and support offered by AWS. Our book focuses on the different aspects of security in the cloud, for example by following the "least privilege" principle when accessing cloud resources.

We focus on Linux as the operating system for virtual machines in the book. Our examples are based on open source software.

Amazon operates data centers in geographic regions around the world. To simplify the examples we are using the region US East (N. Virginia) within our book. You will also learn how to switch to another region to exemplarily make use of resources in Asia Pacific (Sydney).

Roadmap

Chapter 1 introduces cloud computing and Amazon Web Services. You'll learn about key concepts and basics, and you'll create and set up your AWS account.

Chapter 2 brings Amazon Web Services into action. You'll spin up and dive into a complex cloud infrastructure with ease.

Chapter 3 is about working with a virtual machine. You'll learn about the key concepts of the Elastic Compute Service (EC2) with the help of a handful of practical examples.

Chapter 4 presents different approaches for automating your infrastructure: the AWS command-line interface (CLI) from your terminal, the AWS SDKs to program in your favorite language, as well as AWS CloudFormation, an infrastructure-as-code tool.

Chapter 5 introduces three different ways to deploy software to AWS. You'll use each of the tools to deploy an application to AWS in an automated fashion.

Chapter 6 is about security. You'll learn how to secure your networking infrastructure with private networks and firewalls. You'll also learn how to protect your AWS account and your cloud resources.

Chapter 7 is about automating operational tasks with AWS Lambda. You will learn how to execute small code snippets in the cloud without the need of launching a virtual machine.

Chapter 8 introduces Amazon Simple Storage Service (S3), a service offering object storage, and Amazon Glacier, a service offering long-term storage. You'll learn how to integrate object storage into your applications to implement a stateless server by creating an image gallery.

Chapter 9 is about storing data from your virtual machines on hard drives with Amazon Elastic Block Storage (EBS) and instance storage. In order to get an idea of the different options available, you will take some performance measurements.

Chapter 10 explains how to use a networking filesystem to share data between multiple machines. Therefore, we introduce the Amazon Elastic File System (EFS).

Chapter 11 introduces Amazon Relational Database Service (RDS), which offers managed relational database systems like MySQL, PostgreSQL, Oracle, and Microsoft SQL Server. You will learn how to connect an application to an RDS database instance, for example.

Chapter 12 is about adding a cache to your infrastructure to speed up your application and save costs due to minimizing load on the database layer. Specifically, you will learn about Amazon ElastiCache, which provides Redis or memcached as a service.

Chapter 13 introduces Amazon DynamoDB, a NoSQL database offered by AWS. DynamoDB is typically not compatible with legacy applications. You need to rework your applications to be able to make use of DynamoDB instead. You'll implement a to-do application in this chapter.

Chapter 14 explains what is needed to make your infrastructure highly available. You will learn how to recover from a failed virtual machine or even a whole datacenter automatically.

Chapter 15 introduces the concept of decoupling your system to increase reliability. You'll learn how to use synchronous decoupling with the help of Elastic Load Balancing (ELB). Asynchronous decoupling is also part of this chapter; we explain how to use the Amazon Simple Queue Service (SQS), a distributed queuing service, to build a fault-tolerant system.

Chapter 16 dives into building fault-tolerant applications based on the concepts explained in chapter 14 and 15. You will create a fault-tolerant image processing web services within this chapter.

Chapter 17 is all about flexibility. You'll learn how to scale the capacity of your infrastructure based on a schedule or based on the current load of your system.

Code conventions and downloads

You'll find four types of code listings in this book: Bash, YAML, Python, and Node.js/JavaScript. We use Bash to create tiny scripts to interact with AWS in an automated way. YAML is used to describe infrastructure in a way that AWS CloudFormation can understand. In addition, we use Python to manage our cloud infrastructure. Also, we use the Node.js platform to create small applications in JavaScript to build cloud-native applications.

This book contains many examples of source code both in numbered listings and in line with normal text. In both cases, source code is formatted in a `fixed-width font like this` to separate it from ordinary text. Code annotations accompany many of the listings, highlighting important concepts. Sometimes we needed to break a line into two or more to fit on the page. In our Bash code we used the continuation backslash. In our YAML, Python, and Node.js/JavaScript code, an artificial line break is indicated by this symbol: ➥.

The code for the examples in this book is available for download from the publisher's website at https://www.manning.com/books/amazon-web-services-in-action-second-edition and from GitHub at https://github.com/awsinAction/code2.

Book forum

Purchase of *Amazon Web Services in Action, Second Edition* includes free access to a private web forum run by Manning Publications where you can make comments about the book, ask technical questions, and receive help from the author and from other users. To access the forum, go to https://forums.manning.com/forums/amazon-web-services-in-action-second-edition. You can also learn more about Manning's forums and the rules of conduct at https://forums.manning.com/forums/about.

Manning's commitment to our readers is to provide a venue where a meaningful dialogue between individual readers and between readers and the authors can take place. It is not a commitment to any specific amount of participation on the part of the authors, whose contribution to the forum remains voluntary (and unpaid). We suggest you try asking the authors some challenging questions lest their interest stray! The forum and the archives of previous discussions will be accessible from the publisher's website as long as the book is in print.

about the authors

Andreas Wittig and Michael Wittig are software and DevOps engineers focusing on Amazon Web Services. The brothers started building on AWS in 2013 when migrating the IT infrastructure of a German bank to AWS—the first bank in Germany to do so. Since 2015, Andreas and Michael have worked as consultants helping their clients to migrate and run their workloads on AWS. They focus on infrastructure-as-code, continuous deployment, serverless, Docker, and security. Andreas and Michael build SaaS products on top of the Amazon's cloud as well. Both are certified as AWS Certified Solutions Architect - Professional and AWS Certified DevOps Engineer - Professional. In addition, Andreas and Michael love sharing their knowledge and teaching how to use Amazon Web Services through this book, their blog (cloudonaut.io), as well as online- and on-site trainings (such as *AWS in Motion* [https://www.manning.com/livevideo/aws-in-motion]).

about the cover illustration

The figure on the cover of *Amazon Web Services in Action, Second Edition* is captioned "Paysan du Canton de Lucerne," or a peasant from the canton of Lucerne in central Switzerland. The illustration is taken from a collection of dress costumes from various countries by Jacques Grasset de Saint-Sauveur (1757-1810), titled *Costumes de Différent Pays*, published in France in 1797. Each illustration is finely drawn and colored by hand.

The rich variety of Grasset de Saint–Sauveur's collection reminds us vividly of how culturally apart the world's towns and regions were just 200 years ago. Isolated from each other, people spoke different dialects and languages. In the streets or in the countryside, it was easy to identify where they lived and what their trade or station in life was just by their dress.

The way we dress has changed since then and the diversity by region, so rich at the time, has faded away. It is now hard to tell apart the inhabitants of different continents, let alone different towns, regions, or countries. Perhaps we have traded cultural diversity for a more varied personal life—certainly for a more varied and fast-paced technological life.

At a time when it is hard to tell one computer book from another, Manning celebrates the inventiveness and initiative of the computer business with book covers based on the rich diversity of regional life of two centuries ago, brought back to life by Grasset de Saint-Sauveur's pictures.